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Sexual dimorphism among species of *Aleurocanthus* Quaintance & Baker (Hemiptera: Aleyrodidae) in Taiwan, with one new species and an identification key

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Abstract

Sexual dimorphism is recorded among the puparia of six species of *Aleurocanthus* from Taiwan, including *Aleurocanthus lauriphaga* sp.n. from *Cinnamomum osmophloeum*. A key is provided to the puparia of seven species of this genus known from Taiwan, with illustrations of immature stages and the adult male and female of the new species. The flocculent wax secretion pattern in the puparia of this new species is atypical amongst *Aleurocanthus* species. Newly recorded from Taiwan is *A. citriperdus* Quaintance & Baker, and the record of *A. spinosus* (Kuwana) from Taiwan is discussed. A list of recorded host plants of *Aleurocanthus* species from Taiwan is provided.

Key words: Aleyrodidae, *Aleurocanthus*, dimorphism, new species, key

Introduction

The genus *Aleurocanthus*, erected by Quaintance & Baker (1914) for 11 species with stout dorsal glandular spines and an elevated vasiform orifice, is an Old World genus that currently includes 78 species (Martin & Mound, 2007). In the study reported here, seven species in this genus are now recognised from Taiwan of which one is described as a new species. The quality of the descriptions and drawings of *Aleurocanthus* species from the Oriental Region vary considerably, and almost no information is available on sexual dimorphism and variation across puparia. Dubey & Sundararaj (2004) re-described puparial morphology of some of the species, but a few species still need further study, such as *A. singhi* Jesudasan & David (1991). The number of dorsal spines has been used for distinguishing *Aleurocanthus* species, but has remained unclear for the puparia of *A. banksiae* (Maskell). *Aleurocanthus chiengmaiensis* Takahashi is another example of extreme sexual dimorphism (pers. comm. Jon Martin, xi.2011). The sexual dimorphism recorded here for six species indicates that more detailed observations are needed on *Aleurocanthus* species from the Oriental Region that have been described as differing in a small number of spines.

Some previous studies on other genera have recorded dimorphism, involving size of puparia and length of antennae, such as *Chitonaleyrodes* Martin (1999). Puparial dimorphism is recorded here in *Aleurocanthus cinnamomi*, *A. citriperdus*, *A. lauriphaga* sp. nov., *A. spiniferus* and *A. woglumi*, involving puparial size and number of dorsal spines. The original descriptions of these species were clearly based on female puparia. In all these species, the male puparia are smaller and possess fewer dorsal spines than female puparia. Moreover, the submarginal spines are sometimes doubled only on one half of the puparium. Although the number of dorsal spines in these six species varies between male and female puparia, the number on the cephalothorax of female puparia was found to be constant within species, and hence is used here for key characteristics. Dimorphism was also noticed in the third instars of *A. cinnamomi*, *A. citriperdus* and *A. woglumi*; female third instars possessed an extra pair of dorsal spines in contrast to male third instars. In *A. lauriphaga*, female puparia are larger than male puparia, with 27–29 pairs of dorsal spines in males but 39–40 pairs in females, although the length of the antennae differs little between the sexes. In this species, male and female third instars both possessed 14 pairs of spines, but the moulting sutures and abdominal rhachis were clear in females (Fig. 36). These observations indicate that many of the species described from the Oriental Region need more detailed study to determine the extent of their dimorphism.

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TABLE 1. Puparial characteristics and measurements (in microns)

Species/ characters	*A. cinnamomi*		*A. citriperdus*		*A. eugeniae*		*A. lauriphaga* **sp. nov.**		*A. spiniferus*		*A. woglumi*	
	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
PL	770 –810	1180 –1420	770 –780	1050 –1220	810 –850	910 –1210	870 –900	1320 –1420	750 –770	1130 –1270	720 –800	1100 –1050
PW	510 –550	900 –1000	480 –550	860 –1070	580 –630	650 –920	500 –510	1000 –1500	520 –530	870 –970	520 –600	535 –775
Dorsal spines	29	34 ±1	27	32	31 –36	42 –48	27 –29	39 –40	28	30	29	30
Cephalic spines	14	14	11	11	14 –16	13 –16	13	14	13	14	14	13
Abdo. spines	15	19 ±1	16	21	20 –21	23 –33	14 –16	25 –26	15	16	15	17
VOL	42.5 –47.5	52.5 –57.5	50 –60	72.5 –82.5	42.5	50 –56.25	45 –55	47.5 –62.5	67.5 –70	87.5 –100	46.2 –47.5	52.5 –62.5
VOW	52.5 –55	60 –72.5	45 –50	72.5 –87.5	46.25	50 –57.5	50 –62.5	82.5 –85	55 –57.5	65 –100	46.2 –48.7	47.5 –53.7
OPL	22.5 –27.5	27.5	35	37.5 –55	25	27.5 –32.5	32.5 –40	41.2 –42.5	35 –40	50 –57.5	25 –33.7	30 –32.5
OPW	27.5 –28.7	35 –37.5	27.5 –32.5	52.5 –57.5	23.75	27.5 –30	35	32.5 –42.5	41.25 –45	50 –55	27.5 –35	35 –37.5
CeS	62.5	90 –100	107.5	117.5 –160	57.5	57.5 –65	82.5	92.5 –1.12	112.5 –127.5	120 –152.5	52.5 –80	90 –102.5
8thAS	72.5	107.5	60 –78.7	112.5 –127.5	60 –62.5	72.5	72.5 –80	130 –167.5	85 –90	102.5 –115	82.5	92.5
CaS	67.5 –127.5	212.5	75 –125	197.5 –267.5	70	90 –106.5	85	127.5 –170	197.5 –202.5	195 –230	170 –182.5	160 –175
VS	32.5 –47.5	47.5	22.5 –30	42.5 –57.5	21.25	23.75 –30	35	37.5 –45	45 –52.5	75 –77.5	25	45 –50
VSA	30 –32	53.7	35	57.5 –71.25	37.5	41.2 –43.7	33.75	42.5 –62.5	27.5 –42.5	65 –72.5	27.5	50
AMS	20		20		11.25		20		17.5	21.25	17.5	
PMS	40		52.5		22.5		37.5		37.5	52.5	37.5	
Shape	oval		oval		oval		oval		oval		oval	
Margin	crenulate		crenulate		crenulate		toothed		toothed		toothed	

AMS—anterior marginal setae, CaS—caudal setae, CeS- cephalic setae, OPL—operculum length, OPW—operculum width, PC—pupal case, PL—puparial length, PMS—posterior marginal setae, PW—puparial width, 8thAS—Eighth abdominal setae, VOL—vasiform orifice length, VOW—vasiform orifice width, VS—ventral setae, VSA—ventral setae apart.

A. lauriphaga is a dimorphic species, the female puparia being at least twice as wide as those of males (Table 1). Generally, the puparia of *Aleurocanthus* species are found in groups, and exuviae of previous instars remain adhering. However, *A. lauriphaga* puparia were found singly and without exuviae of the previous instars on the dorsum. The flocculent wax secretion pattern around the margin/submargin of puparia of this species is unusual among *Aleurocanthus* species, and this wax required manual removal. The wax almost reaches the apex of the marginal spines, leaving only the apices of spines exposed. The wax secretion pattern did not differ between male and female puparia in *A lauriphaga*, and the submedian area of all puparia remained exposed and shiny black. In some *Aleurocanthus* species, the marginal wax fringe extends horizontally (ex. *A. arecae* David & Manjunatha), and leaves the dorsal surface clear, whereas in *A. lauriphaga*, the wax was heavily deposited dorsally on submargin. The arrangement of submarginal spines in transverse rows supports fluffy wax that must be cleaned manually from each puparium. In life, the dorsal spines of some *Aleurocanthus* species carry drops of transparent/yellow gelati-

nous wax at their tips (Fig. 65). Our observations confirm that each dorsal spine in these *Aleurocanthus* species has a minute pore near the apex and this possibly serves the purpose of secreting liquid wax (Dubey *et al*., 2010), and the discharged liquid from these pores remains on the apex of the spines. On over-bleached puparia, the dorsal spines curve slightly from the position of the minute pores near the apex. This phenomenon is sometimes mistaken as a characteristic of the spine itself, and referred to in literature as "depressed tip of spines", also "folding" of spines over themselves and "fixing of apical part into basal socket". The puparial cuticle of the new species appears harder than is usual among *Aleurocanthus* species; it took seven to ten days to bleach with 10% KOH, but turned brown in two to three days when treated with cold 2% H_2O_2 at room temperature. When these puparia were treated with hot (40–60ºC) H_2O_2, they bleached unequally.

Material and Methods

The whitefly puparia examined in this study were from field collections, National Taiwan University (NTU) and Taiwan Agricultural Research Institute (TARI), Taiwan. Puparia were mounted using the method suggested by Martin (1987). Some of the puparia of *A. lauriphaga* were bleached using H_2O_2, washed in ethyl alcohol, and then mounted in euparal. The mounted specimens of known species, and the holotype of the new species are deposited in the collection of NTU, Taiwan. One paratype of the new species will be deposited each in the Natural History Museum, U.K.; United States Department of Agriculture, Maryland, U.S.A.; Indian Agricultural Research Institute, New Delhi, India; TARI, Zoological Survey of India, Kolkata, India and remainder will be in the collection of NTU. The terminology for morphological structures followed Bink-Moenen (1983), Martin (1985), and Gill (1990). Micro-measurements and camera lucida drawings were made using an Olympus (Japan) BK 51 microscope located in the Department of Entomology, NTU, Taiwan. The names of host plant genera are abbreviated in the lists of material examined, but are given in full in Table 2.

TABLE 2. Host plants of *Aleurocanthus* species from Taiwan.

Host plant family	Host plant species	Whitefly species	References
Actinidiaceae	*Actinidia* sp.	*A. woglumi*	new record
Amaranthaceae (=Chenopodiaceae)	*Madhuca latifolia* (=*Bassia latifolia*)	*A. woglumi*	Dietz & Zetek, 1920
Anacardiaceae	*Anacardium occidentale*	*A. woglumi*	Dietz & Zetek, 1920
	Mangifera indica	*A. woglumi*	Dietz & Zetek, 1920
Annonaceae	*Annona cherimola*	*A. woglumi*	Dietz & Zetek, 1920
	Annona muricata	*A. woglumi*	Dietz & Zetek, 1920
	Annona reticulata	*A. spiniferus*	Takahashi, 1941
	Annona squamosa	*A. rugosa*	Dubey & Ko, 2008
		A. spiniferus	Takahashi, 1941
		A. woglumi	Dietz & Zetek, 1920
	Polyalthia longifolia	*A. rugosa*	David & Subramaniam, 1976
	Polyalthia pendula	*A. rugosa*	David & Subramaniam, 1976
	Annona sp.	*A. rugosa*	David & Subramaniam, 1976
Apocynaceae	*Plumeria acutifolia*	*A. woglumi*	Corbett, 1926
Arecaceae	*Elaeis melanococca*	*A. woglumi*	Dietz & Zetek, 1920
Begoniaceae	*Begonia* sp.	*A. woglumi*	Dietz & Zetek, 1920
Betulaceae	*Alnus formosana*	*A. spiniferus*	new record

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Host plant family	Host plant species	Whitefly species	References
Bignoniaceae	*Crescentia cujete*	*A. woglumi*	Dietz & Zetek, 1920
Boraginaceae	*Cordia alba*	*A. woglumi*	Dietz & Zetek, 1920
Capparaceae	*Capparis pedunculosus*	*A. woglumi*	Corbett, 1926
	Capparis roxburghi	*A. woglumi*	Corbett, 1926
Caricaceae	*Carica papaya*	*A. woglumi*	Dietz & Zetek, 1920
Celastraceae	*Gymnosporia diversifolia*	*A. woglumi*	Takahashi, 1935
	Kurrimia zeylanica	*A. woglumi*	Corbett, 1926
	Salacia reticulata	*A. woglumi*	Corbett, 1926
Combretaceae	*Terminalia catappa*	*A. citriperdus*	new record
Convolvulaceae	*Erycibe acutifoliae*	*A. spiniferus*	Takahashi, 1933
Doddonaceae	*Dodonaea viscosa*	*A. rugosa*	Jesudasan & David, 1991
Ebenaceae	*Diospyros kaki*	*A. spiniferus*	Kuwana, 1928
Elaeocarpaceae	*Sloanea dasycarpa*	*A. spiniferus*	Takahashi, 1956
Ericaceae	*Rhododendron ellipticum*	*A. spiniferus*	new record
Euphorbiaceae	*Bischofia javanica*	*A. citriperdus*	new record
	Croton sp.	*A. woglumi*	Dietz & Zetek, 1920
	Macaranga tanarius	*A. spiniferus*	Martin, 1999
	Sapium sabiferum	*A. spiniferus*	Mound & Halsey, 1978
Fabaceae	*Adinobotrys atropurpureus*	*A. woglumi*	Corbett, 1935b
	Bauhinia championii	*A. spiniferus*	new record
	Bauhinia blinii	*A. spiniferus*	new record
	Entada phaseoloides	*A. spiniferus*	Martin, 1999
	Ficus sp.	*A. spiniferus*	Martin, 1999
Flacourtiaceae	*Myroxylon japonicum*	*A. spiniferus*	Kuwana, 1928
	Scolopia oldhami	*A. spiniferus*	new record
		A. woglumi	Takahashi, 1935
Hamamelidaceae	*Liquidambar formosana*	*A. spiniferus*	Takahashi, 1956
Lardizabalaceae	*Akebia lobata*	*A. spiniferus*	Kuwana, 1928
	Akebia longeracemosa	*A. spiniferus*	new record
Lauraceae	*Actinodaphne* sp.	*A. cinnamomi*	Takahashi, 1940
	Cinnamomum camphora	*A. cinnamomi*	Takahashi, 1931
	Cinnamomum camphora var. *nominale*	*A. cinnamomi*	Takahashi, 1931
	Cinnamomum osmophloeum	*A. lauriphaga* **sp. nov**.	new record
	Laurus nobilis	*A. woglumi*	Dietz & Zetek, 1920
	Machilus kusanoi	*A. cinnamomi*	new record
	Machilus zuihoensis	*A. cinnamomi*	new record
		A. woglumi	new record
	Machilus sp.	*A. cinnamomi*	Takahashi, 1931

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Host plant family	Host plant species	Whitefly species	References
	Persea gratissima	*A. woglumi*	Dietz & Zetek, 1920
	Phoebe formosana	*A. spiniferus*	new record
	Phoebe zhennan	*A. cinnamomi*	new record
Lythraceae	*Lagerstroemia indica*	*A. woglumi*	Dietz & Zetek, 1920
Loranthaceae	*Loranthus* sp.	*A. woglumi*	Corbett, 1926
Magnoliaceae	*Michelia champaca*	*A. rugosa*	Singh, 1931
	Michelia formosana	*A. cinnamomi*	new record
Malpighiaceae	*Malpighia glabra*	*A. woglumi*	Dietz & Zetek, 1920
Malvaceae	*Hibiscus rosa-chinensis*	*A. woglumi*	Dietz & Zetek, 1920
	Hibiscus schizopetalus	*A. woglumi*	Dietz & Zetek, 1920
Meliaceae	*Trichila auranticola*	*A. woglumi*	Dietz & Zetek, 1920
	Trichila spondiodes	*A. woglumi*	Dietz & Zetek, 1920
Moraceae	*Morus* sp.	*A. woglumi*	Quaintance & Baker, 1916
Musaceae	*Musa paradisica*	*A. woglumi*	Dietz & Zetek, 1920
	Musa sapientum	*A. woglumi*	Dietz & Zetek, 1920
Myrsinaceae	*Maesa perlaria*	*A. spiniferus*	new record
	Wallenia laurifolia	*A. woglumi*	Dietz & Zetek, 1920
Myrtaceae	*Psidium guajava*	*A. rugosa*	Singh, 1931
		A. woglumi	Dietz & Zetek, 1920
	Syzygium jambolana	*A. rugosa*	Singh, 1931
	Syzygium jambos	*A. woglumi*	Dietz & Zetek, 1920
	Syzygium malaccensis	*A. woglumi*	Dietz & Zetek, 1920
	Syzygium samarangenes	*A. spiniferus*	new record
	Syzygium sp. (=*Eugenia* sp.)	*A. eugeniae*	Takahashi, 1933
Passifloraceae	*Passiflora edulis*	*A. woglumi*	Dietz & Zetek, 1920
Piperaceae	*Piper betel*	*A. rugosa*	Singh, 1931
	Piper futokadsura	*A. rugosa*	Takahashi, 1931 (misidentification)
	Kadsura piper	*A. rugosa*	new record
		A. spiniferus	new record
Polygonaceae	*Antigonon leptopus*	*A. woglumi*	Dietz & Zetek, 1920
Punicaceae	*Punica granatum*	*A. woglumi*	Dietz & Zetek, 1920
Rhamnaceae	*Zizyphus rugosa*	*A. rugosa*	Dubey & Ko, 2008
Rosaceae	*Eryobotrya japonica*	*A. spiniferus*	Takahashi, 1934b
	Hibiscus tiliaceus	*A. spiniferus*	Martin, 1999
	Pyracantha formosana	*A. woglumi*	Takahashi, 1935
	Pyrus serotina	*A. spiniferus*	Kuwana, 1928
	Rosa indica	*A. spiniferus*	Kuwana, 1928
	Rosa sinensis	*A. spiniferus*	Mound & Halsey, 1978
	Rosa sp.	*A. spiniferus*	Dubey & Ko, 2008

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Host plant family	Host plant species	Whitefly species	References
Rubiaceae	*Coffea arabica*	*A. woglumi*	Corbett, 1935b
	Gardenia florida	*A. rugosa*	Takahashi, 1931
	Gardenia jasminoides	*A. spiniferus*	new record
	Ixora thwaitesii	*A. woglumi*	Dietz & Zetek, 1920
	Morinda tinctoria	*A. woglumi*	David & Subramaniam, 1976
	Mussaendra pubescens	*A. spiniferus*	new record
Rutaceae	*Citrus acida*	*A. citriperdus*	Corbett, 1935b
	Citrus aruntifolia	*A. woglumi*	Dietz & Zetek, 1920
	Citrus aurantium	*A. citriperdus*	Corbett, 1935b
		A. woglumi	Corbett, 1926
	Citrus grandis	*A. woglumi*	Dietz & Zetek, 1920
	Citrus hystrix	*A. citriperdus*	Corbett, 1935b
	Citrus limon	*A. spiniferus*	Mound & Halsey, 1978
	Citrus limonum	*A. citriperdus*	Corbett, 1935b
		A. woglumi	Corbett, 1926
	Citrus medica	*A. woglumi*	Dietz & Zetek, 1920
	Citrus nobilis	*A. citriperdus*	Mound & Halsey, 1978
	Citrus nobilis var. *deliciosa*	*A. woglumi*	Dietz & Zetek, 1920
	Citrus reticulata	*A. woglumi*	Mound & Halsey, 1978
	Citrus sinensis	*A. citriperdus*	Evans, 2007a
		A. spiniferus	Mound & Halsey, 1978
		A. woglumi	Dietz & Zetek, 1920
	Clausena lansium	*A. woglumi*	Dietz & Zetek, 1920
	Murraya [*chalcas*] *exotica*	*A. woglumi*	Dietz & Zetek, 1920
	Murraya koenigii	*A. spiniferus*	Dubey & Ko, 2008
		A. woglumi	David & Subramaniam, 1976
	Murraya paniculata	*A. woglumi*	Dubey & Ko, 2008
	Zanthoxylum [*Fagara*] *nitida*	*A. spiniferus*	Takahashi, 1956
Sabiaceae	*Meliosma rigida*	*A. spiniferus*	Takahashi, 1933
Salicaceae	*Salix* sp.	*A. spiniferus*	Takahashi, 1956
Sapindaceae	*Cupania cubensis*	*A. woglumi*	Dietz & Zetek, 1920
	Melicocca bijuga	*A. woglumi*	Dietz & Zetek, 1920
Sapotaceae	*Achras sapota*	*A. woglumi*	Dietz & Zetek, 1920
	Chrysophyllum cainito	*A. woglumi*	Dietz & Zetek, 1920
	Lucuma mammosa	*A. woglumi*	Dietz & Zetek, 1920
	Lucuma nervosa	*A. woglumi*	Dietz & Zetek, 1920
	Manilkara zapota	*A. woglumi*	Dubey & Ko, 2008
Solanaceae	*Cestrum diurnum*	*A. woglumi*	Dietz & Zetek, 1920
	Cestrum nocturnum	*A. woglumi*	Quaintance & Baker, 1916

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Host plant family	Host plant species	Whitefly species	References
Sterculiaceae	*Guazuma tomentosa*	*A. woglumi*	Dietz & Zetek, 1920
Urticaceae	*Boehmeria densiglomerata*	*A. spiniferus*	new record
Vitaceae	*Vitis vinifera*	*A. spiniferus*	Kuwana, 1928
Zygophyllaceae	*Guaiacum officinale*	*A. woglumi*	Quaintance & Baker, 1916

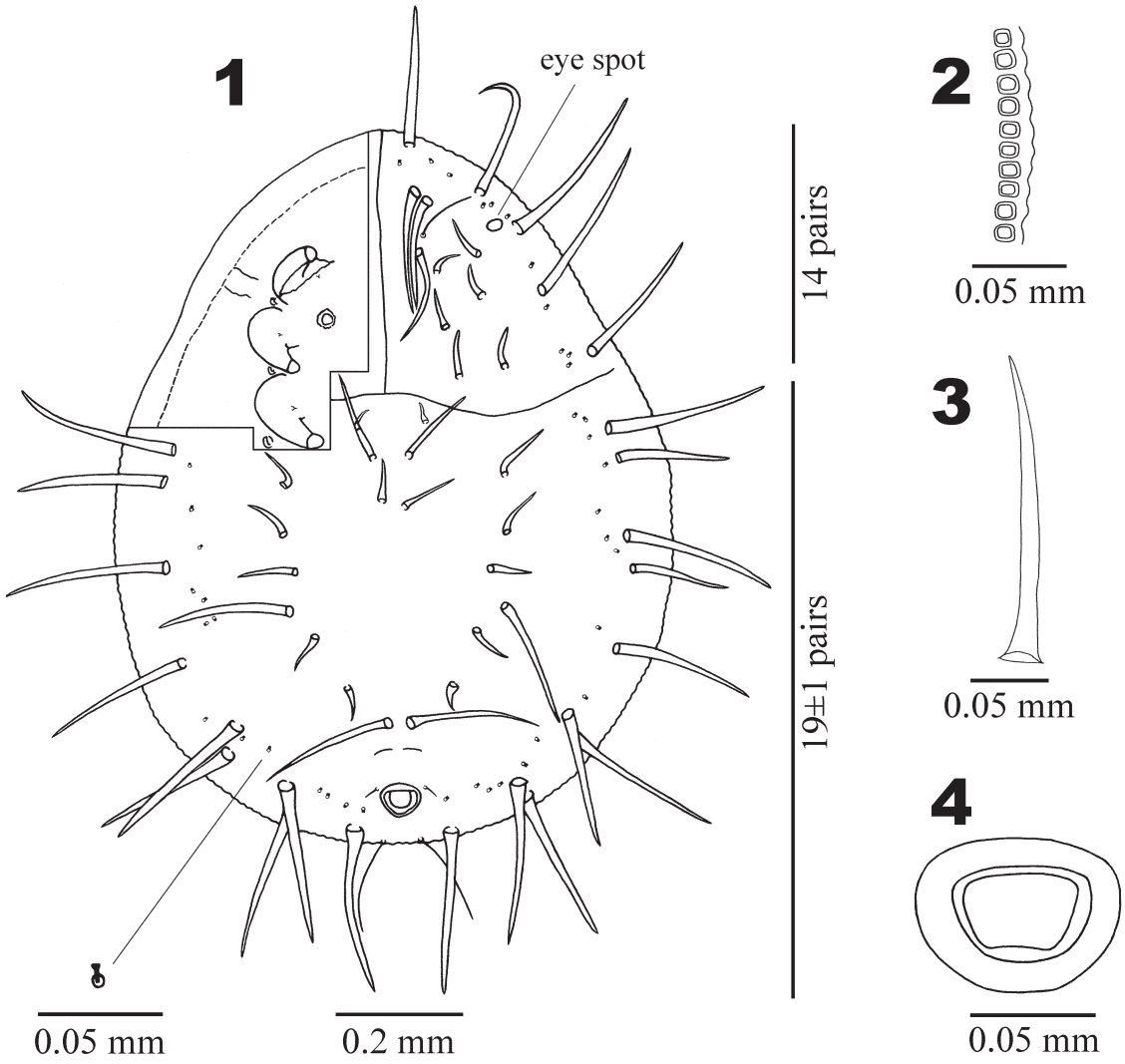
Aleurocanthus Quaintance & Baker

Aleurocanthus Quaintance & Baker, 1914: 102. Type species: *Aleurodes spinifera* Quaintance, 1903: 63–64, by original description.

Diagnosis. Puparia mostly in groups, male puparia usually much smaller than female, exuviae of earlier instars habitually remain on the dorsum of puparia, cuticle usually black, sometimes pale brown, often with fringe of marginal wax secretion; margin lobulate, serrate or toothed, wax secreting glands often present at base of marginal "teeth" in the form of transparent area. Tracheal pore areas not indicated except *A. hirsutus* (Maskell). Dorsum with stout glandular spines on submargin and subdorsum, spines apically pointed or fimbriate; sometimes with drops of gelatinous yellow wax at apices. Longitudinal and transverse moulting sutures reach the margin. Submargin usually with minute setae. Cephalic, eighth abdominal and caudal setae present. First abdominal segment with a pair of glandular spines often referred to as setae. Vasiform orifice posteriorly elevated, subcircular to subcordate or rectangular, floor usually weakly ridged, almost occupied by operculum, lingula obscured. Caudal ridges and furrows absent. Ventrally, submargin sometimes with one or more rows of wax plates; length of antennae varies between male and female puparia, leg pads and spiracles well developed. Martin (1999) stated that puparia of some species have glandular spines reduced and located on tubercles; these species were included in *Aleurocanthus* based on the presence of spines in third instar larvae.

Key to puparia of *Aleurocanthus* species from Taiwan

1. Puparium pale, dorsal spines with laciniate apices (Fig. 53) . . . . . *A. rugosa*
-. Puparium black, apex of spines pointed or bifurcated 2
2. Glandular spines present only on submargin and first abdominal segment, apex of spines bifurcated, none of them reaching well beyond margin; dorsum with prominent pores (Fig. 28); operculum filling half the length of orifice; ventral subdorsum with band of spinules. . . . . *A. eugeniae*
-. Glandular spines present on all the dorsal areas, apex of spines pointed, most of them reaching well beyond margin; operculum almost filling the orifice; venter without dense spinules. 3
3. Vasiform orifice transversely elliptical in female puparia and subrectangular in male puparia; abdominal submedian spines almost uniform in size; marginal teeth much chitinised; submarginal spines on abdomen placed in transverse rows with closely placed bases of two to four spines; host plant *Cinnamomum osmophloeum* (Fig. 32). . . . . *A. lauriphaga* **sp. nov.**
-. Vasiform orifice cordate in both female and male puparia; abdominal submedian spines not uniform in size; usually the 4th and 7th pairs of spines longer than other submedian pairs; marginal teeth concolourous with remainder of cuticle; submarginal spines not placed in transverse rows, but bases of posterior-most 2nd and/or 3rd submarginal spines placed close together 4
4. Margin toothed; submargin with 11 pairs of spines, of which five pairs on cephalothorax; none or only one pair of the submarginal spines may be doubled at posterior abdominal area. 5
-. Margin crenulate; submargin with 15 or 16 pairs of spines, of which five pairs on cephalothorax; two pairs of submarginal spines may be doubled at posterior abdominal area 6
5. Female puparium with 29 pairs of dorsal spines, of which 12 pairs on submargin; the 3rd posterior-most submarginal spines usually doubled at base . . . . . *A. woglumi*
-. Female puparium with 30 pairs of dorsal spines, of which 11 pairs on submargin (Fig. 55); all the submarginal spines placed singly . . . . . *A. spiniferus*
6. Transverse moulting suture turned anterolaterally; cephalic submedian/subdorsum with six pairs of spines; eye spots absent; none of the submarginal spines doubled at base (Fig. 9); usually from *Citrus* species . . . . . *A. citriperdus*
-. Transverse moulting suture not turned anterolaterally; cephalic submedian/ subdorsum with 9 pairs of spines; eye spots slightly elevated; the 2nd and 3rd submarginal spines on posterior abdominal area doubled at base (Fig. 1); usually from Lauraceae . . . . . *A. cinnamomi*



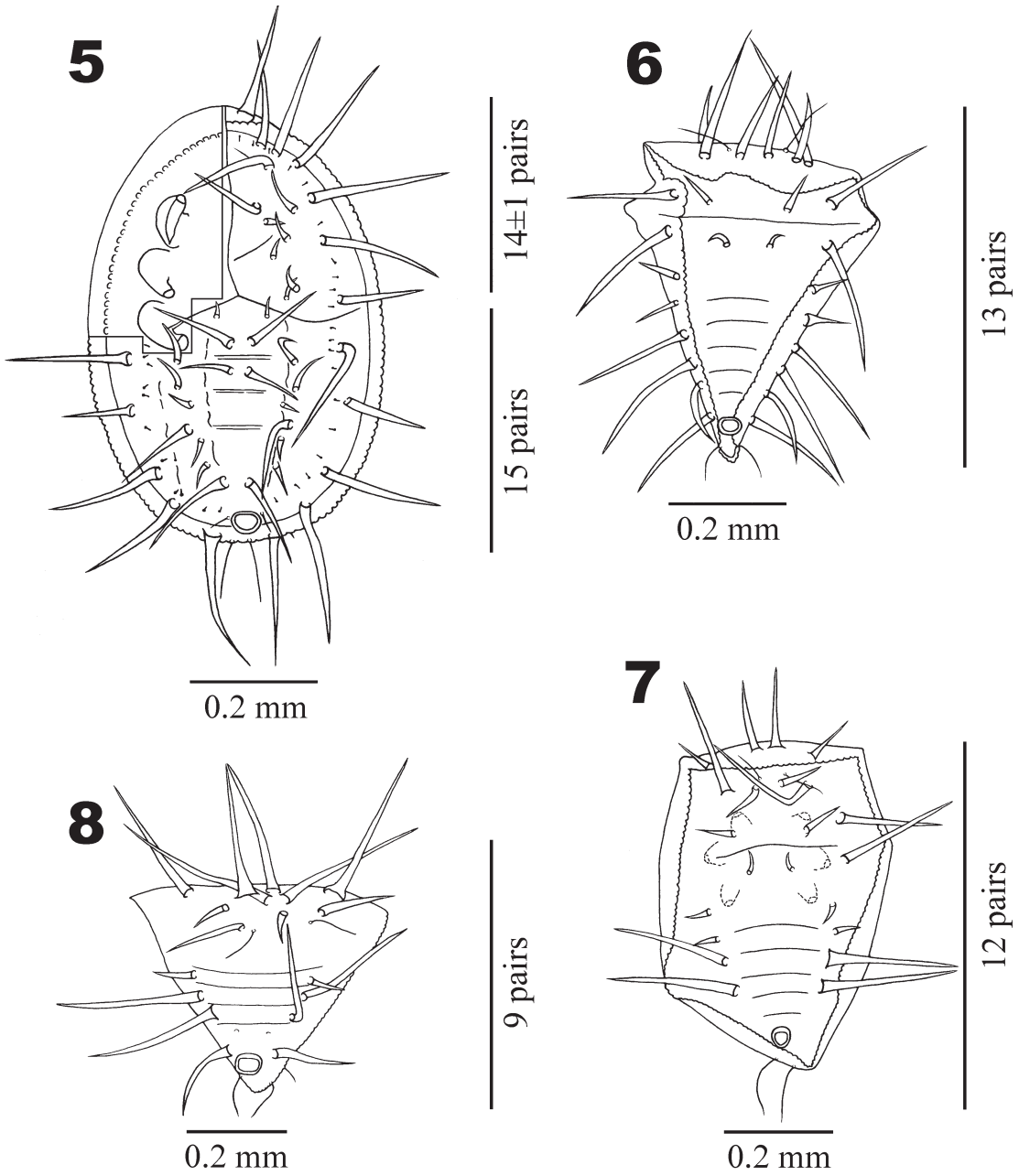
FIGURES 1–4 *A. cinnamomi*, Taiwan (NTU). 1, puparium, female, dimorphism. 2, margin and wax glands. 3, dorsal spine. 4, vasiform orifice.

***Aleurocanthus cinnamomi* Takahashi** (Figs 1–8, 64, Table 1–2)

Aleurocanthus cinnamomi Takahashi, 1931: 205–206.
Aleurodes spinosus Kuwana; misidentification in Maki, 1915: 31; Shiraki, 1913: 107.

Distribution. Japan (Takahashi, 1940); Taiwan (Takahashi, 1931).

Material examined. Taiwan: Kenting, 1 ♀ puparium on *M. kusanoi*, 21.iv.1994, C. C. Ko (650); Taipei, 1 ♀ puparium on *P. zhennan*, 16.iv.1994 (615); Baitou, 18 ♀ & 29 ♂ puparia, 31 third instars, 9 second instars on 7 slides on *M. formosana*, 9.ii.2010, J. R. Liao (5742); 29 ♀ & 8 ♂ puparia, 1 third instar on 2 slides (4818); 6 ♀ & 30 ♂ puparia, 2 ♀ third instar, 1 second instar on 2 slides (4810); 22 ♀ & 40 ♂ puparia, 1 ♀ third instar, 2 second instars on 4 slides (4813), 11 ♀ & 14 ♂ puparia, 1 ♀ third instar, 1 ♂ third instar on 3 slides (4808); 10 ♀ & 29 ♂ puparia, 1 ♀ third instar, 2 second instars on 2 slides (4821); 9 ♀ & 7 ♂ puparia, 3 ♀ & 3 ♂ third instars on 4 slides; 34 ♀ & 33 ♂ puparia, 1 ♀ third instar, 1 second instar (4828), all on *M. zuihoensis*, 18.xii.2008, all A. K. Dubey & Y. T. Shih (NTU).



FIGURES 5–8 *A. cinnamomi*, Taiwan (NTU). 5, puparium, male, dimorphism. 6, third instar, female. 7, third instar, male. 8, second instar.

FEMALE PUPARIA. Additional notes except those in Takahashi (1931): each marginal tooth with a wax secreting gland at base. Submarginal spines 14 pairs, five pairs on cephalothorax, and nine pairs on abdomen of which, posterior 3rd and 4th pairs are placed close together at base, sometimes ±1 or one pair of spines observed in addition to usual abdominal pairs on one half of puparium. Submarginal minute setae present, obtuse. Antennae reaching base of prolegs.

MALE PUPARIA. Elongate oval; longitudinal and transverse moulting sutures almost reaching margin. Submargin with a row of minute setae along the bases of submarginal spines; 29 pairs of dorsal spines (14 pairs on cephalothorax and 15 pairs on abdomen), of which, five pairs each on cephalothoracic and abdominal submargin. Operculum notched in middle, lingula tip visible. Abdominal segments suture visible. Geminate pores present on subdorsum. Antennae reaching 1/3rd of prolegs. Adhesive sacs and spiracles visible.

THIRD INSTAR FEMALE. Cephalothorax with 7 pairs of spines, 1 pair of spine on submedian area of first abdominal segment and 6 pairs on abdominal subdorsum. Transverse moulting suture present while longitudinal moulting suture not visible.

Third instar males have one pair less number of spines on cephalothorax.

SECOND INSTAR. Cephalothorax with five pairs of spines, one pair of spines on first abdominal segment and four pairs on abdominal subdorsum.

Remarks. The length of the antennae differs little between male and female puparia but the number of submarginal spines was four pairs less in male puparia, none of them with their bases placed close together as in female puparia.

Aleurocanthus citriperdus Quaintance & Baker (Figs 9–27, Table 1–2)

Aleurocanthus citriperdus Quaintance & Baker, 1916: 459–463.
Aleurocanthus cameroni Corbett, 1935b: 799–800. Synonymised by Mound & Halsey, 1978: 14.

Distribution. Hong Kong, Vietnam (Silvestri, 1927); India, Sri Lanka (Quaintance & Baker, 1916); Malaysia (Clausen, 1934); China, Philippines, Singapore, Taiwan (Wu, 1935); Burma (Pruthi & Mani, 1945); Bangladesh, Cambodia, Indonesia, Japan, Thailand (Evans, 2007a).

Material examined. Taiwan: Baitou, 159 ♀ & 11 ♂ puparia, 20 third instars, 8 second instars, 45 ♀ & 37 ♂ adults, on 33 slides, *C. sinensis*, 18.xii.2008 (4837); Gongguan, 3 ♀ puparia on *T. catappa*, 13.i.2009 (4861); 1 ♀ & 1 ♂ puparium on *B. javanica*, 13.i.2009 (4862), all A. K. Dubey & Y. T. Shih (NTU).

PUPARIUM FEMALE. In life, puparia occur in dense aggregation on lower surface of leaves, marginal area surrounded by a fringe of white wax; oval.

PUPARIUM MALE. Oval, much smaller than female puparia, 27 pairs of dorsal spines, 11 pairs on cephalothorax and 16 pairs on abdomen. The number and position of spines on cephalothorax were similar to female puparia, but observed five pairs less on abdominal submarginal area.

MALE THIRD INSTAR. Longitudinal moulting suture not visible, but transverse moulting suture present; submarginal setae present in a row; 13 pairs of dorsal spines, five pairs anterior to the transverse moulting suture and 8 pairs posterior to it.

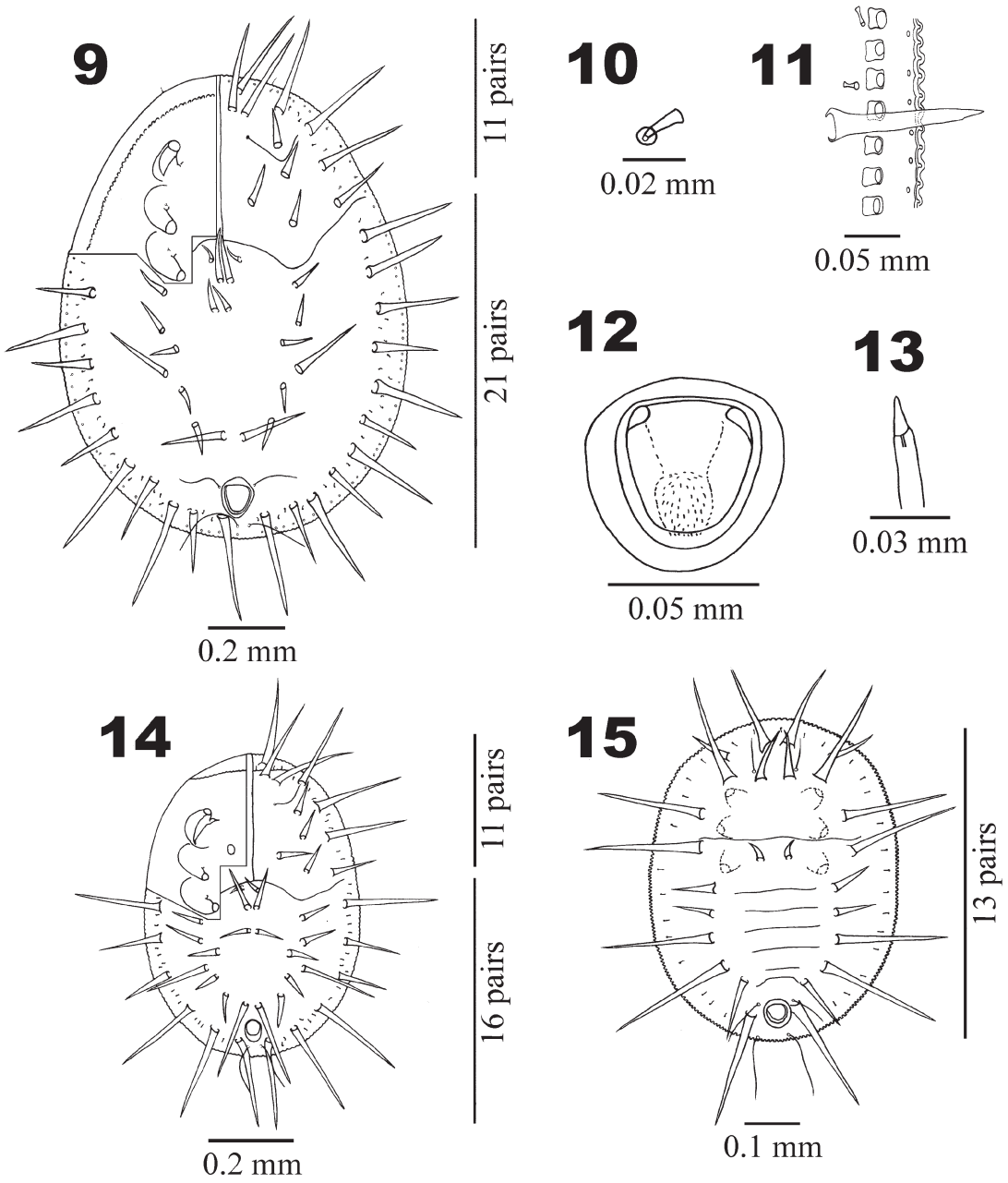
FEMALE THIRD INSTAR. Length 670 µm, width 470 µm. Margin toothed, 14 teeth in 0.1 mm. Dorsum with 14 pairs of spines; submarginal setae present; cephalic setae 112.5 µm long, eighth abdominal setae 75 µm long; caudal setae 145–175 µm long, ventral setae 25–32.5 µm long, 27.5 µm apart. Vasiform orifice 50 µm long, 52.5 µm wide; operculum 40 µm long, 37.5 µm wide.

SECOND INSTAR. Longitudinal and transverse moulting sutures absent; abdominal segments suture faintly visible; 10 pairs of dorsal spines. Eighth abdominal setae present.

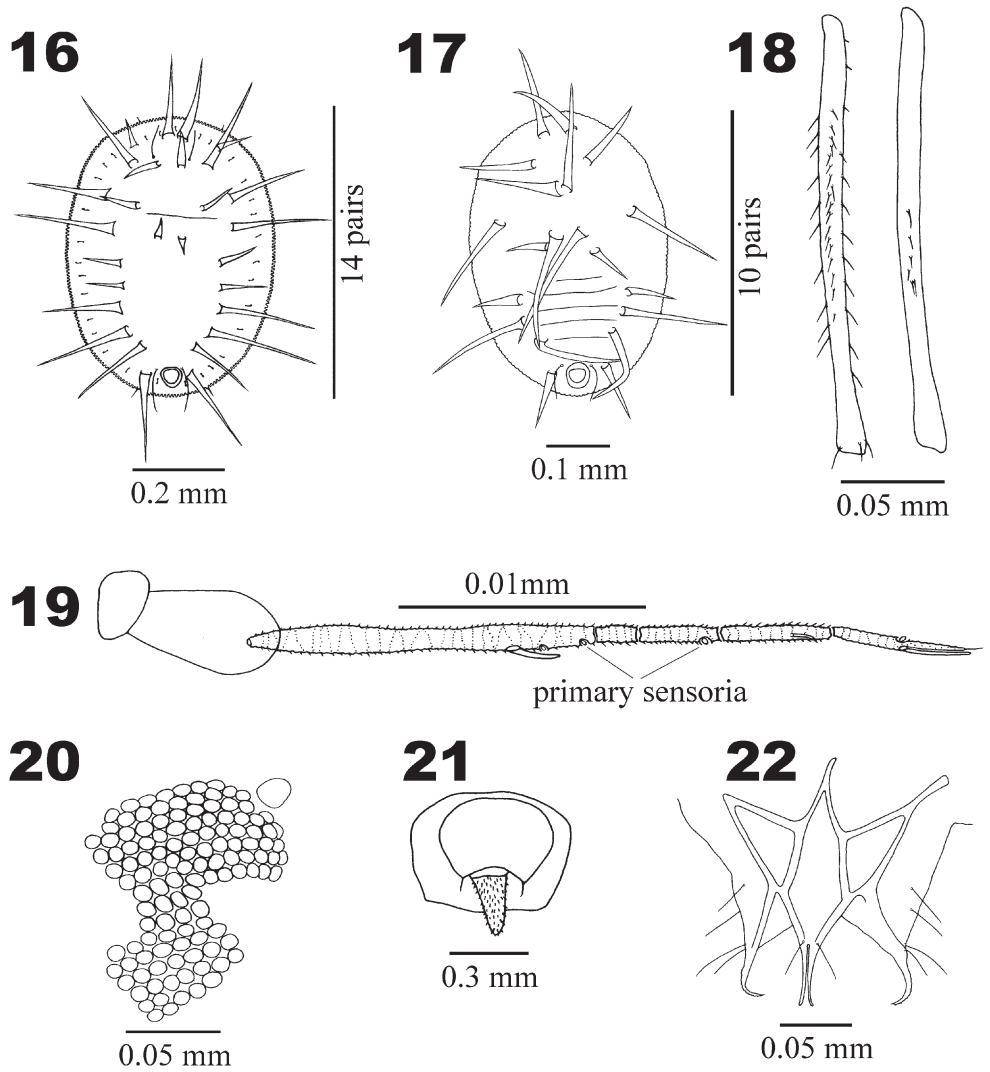
ADULT FEMALE. Antennae seven segmented, one sensorial cone each on segment III, VI and VII; four primary sensoria, two on segment III and one each on segment V and VII; segment IV smallest; apical seta on segment VII present. Metatibial comb comprises 17 setae, metatibial brush comprises two setae. Upper and lower lobes of compound eye joined by four facets. Vasiform orifice posteriorly truncate, operculum posteriorly notched, posterior-lateral margin of operculum with a pair of setae; lingula two segmented, basal segment four times smaller than apical. Paired gonopophyses with four pairs of setae, of which, posterior two setae are placed close together, outer apical margins of paired gonopophyses serrated; unpaired gonopophysis with one pair of setae.

ADULT MALE. Same as for female except: four pairs of abdominal wax plates, each associated with two setae on inner margin and one seta on outer margin. Metatibial comb comprises 13 setae. Antennae seven segmented, one sensorial cone each on segment III, VI and VII, two sensoria on segment III, and one each on V and VII; apical seta present on segment VII. Vasiform orifice subcordate, operculum without setae on posterior lateral margin; four setae on each side of vasiform orifice; each clasper with nine setae on mid-dorsal surface, two setae on mid-ventral surface, and nine setae variably placed along inner and outer margin; subapical tooth present.

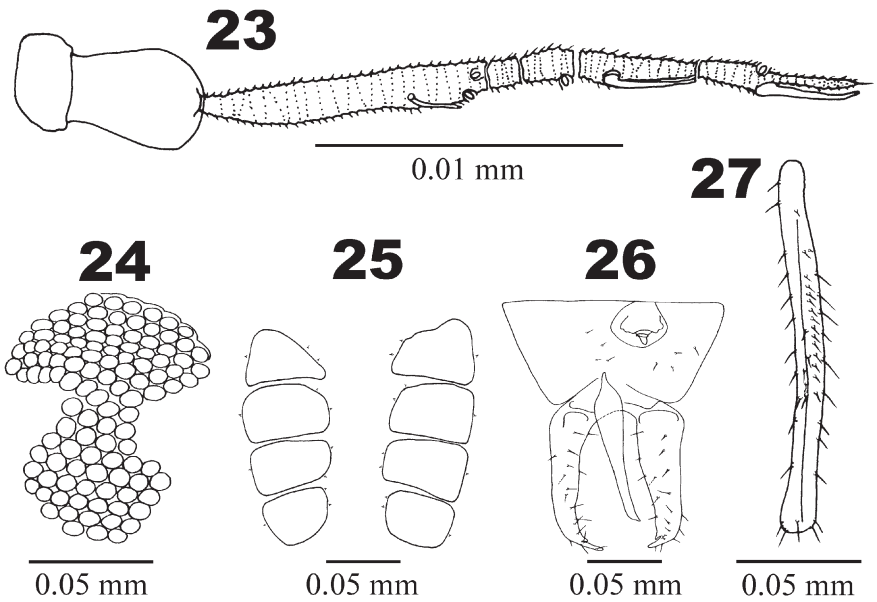
Remarks. This whitefly is newly invasive to Taiwan. In life, the puparia were found in dense aggregations on the lower surface of leaves, with a fringe of white wax around the margin. It is known to infest mainly *Citrus* species. Sexual dimorphism is evident between male and female puparia. The female puparia were larger and with more dorsal spines than male puparia, and the antennae reaches 1/3rd of the proleg length in female puparia but only to the base of the prologs in male puparia. Wu (1935) recorded this species from Taiwan, but as no material was available for study it is placed here as new record.



FIGURES 9–15 *A. citriperdus*, Taiwan (NTU). 9, puparium, female, dimorphism. 10, submarginal seta. 11, margin and submargin. 12, vasiform orifice. 13, apex of dorsal spine. 14, puparium, male, dimorphism. 15, third instar, male.



FIGURES 16–22 *A. citriperdus*, Taiwan (NTU). 16, third instar, female. 17, second instar. 18–22, adult female. 18, metatibia. 19, antenna. 20, compound eye. 21, vasiform orifice. 22, genitalia.



FIGURES 23–27 *A. citriperdus*, adult male, Taiwan (NTU). 23, antenna. 24, compound eye. 25, abdominal wax plates. 26, genitalia. 27, metatibia.

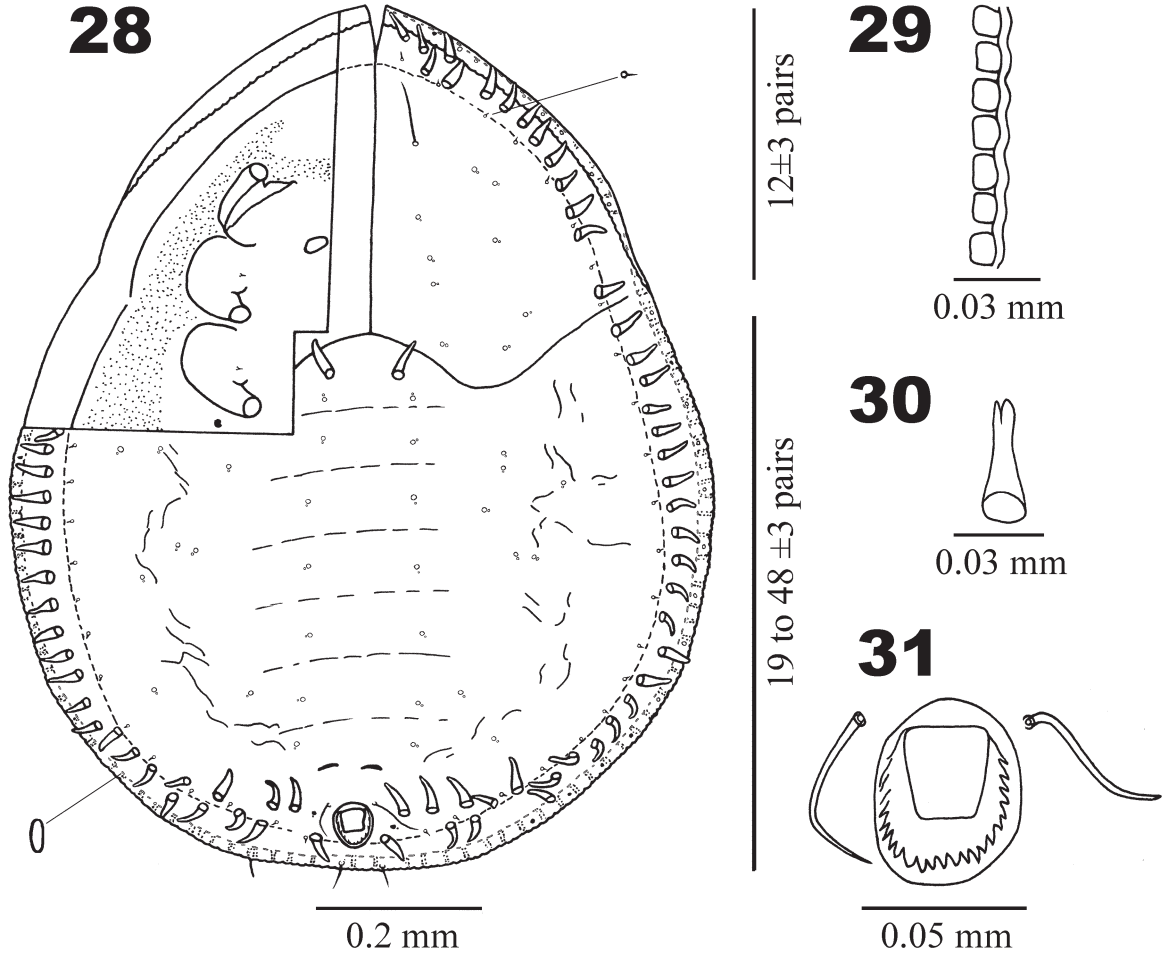
***Aleurocanthus eugeniae* Takahashi** (Figs 28–31, Table 1–2)

Aleurocanthus eugeniae Takahashi, 1933: 20–21.

Distribution. Taiwan (Takahashi, 1933).

Material examined. Taiwan: Nan Ren Hu, 12 ♀ & 6 ♂ puparia on nine slides, on unidentified plant, 24.ii.1990, C. C. Ko (15, 22) (NTU).

Remarks. This species shows sexual dimorphism (Table 1). Male puparia have 31–36 pairs of submarginal spines and female puparia have 42–48 pairs, and ±3 in each half of the puparium. The description by Takahashi (1933) lacks details of variation in the dorsal setae. The abdominal submedian area has a pair of geminate pores, and similar pores are scattered on the cephalothorax and abdominal subdorsal area. The abdominal segmental sutures and dorsal pores are clear as in most Aleurodinae taxa. The ventral submargin is marked by a fine fold and the subdorsum by a band of spinules.

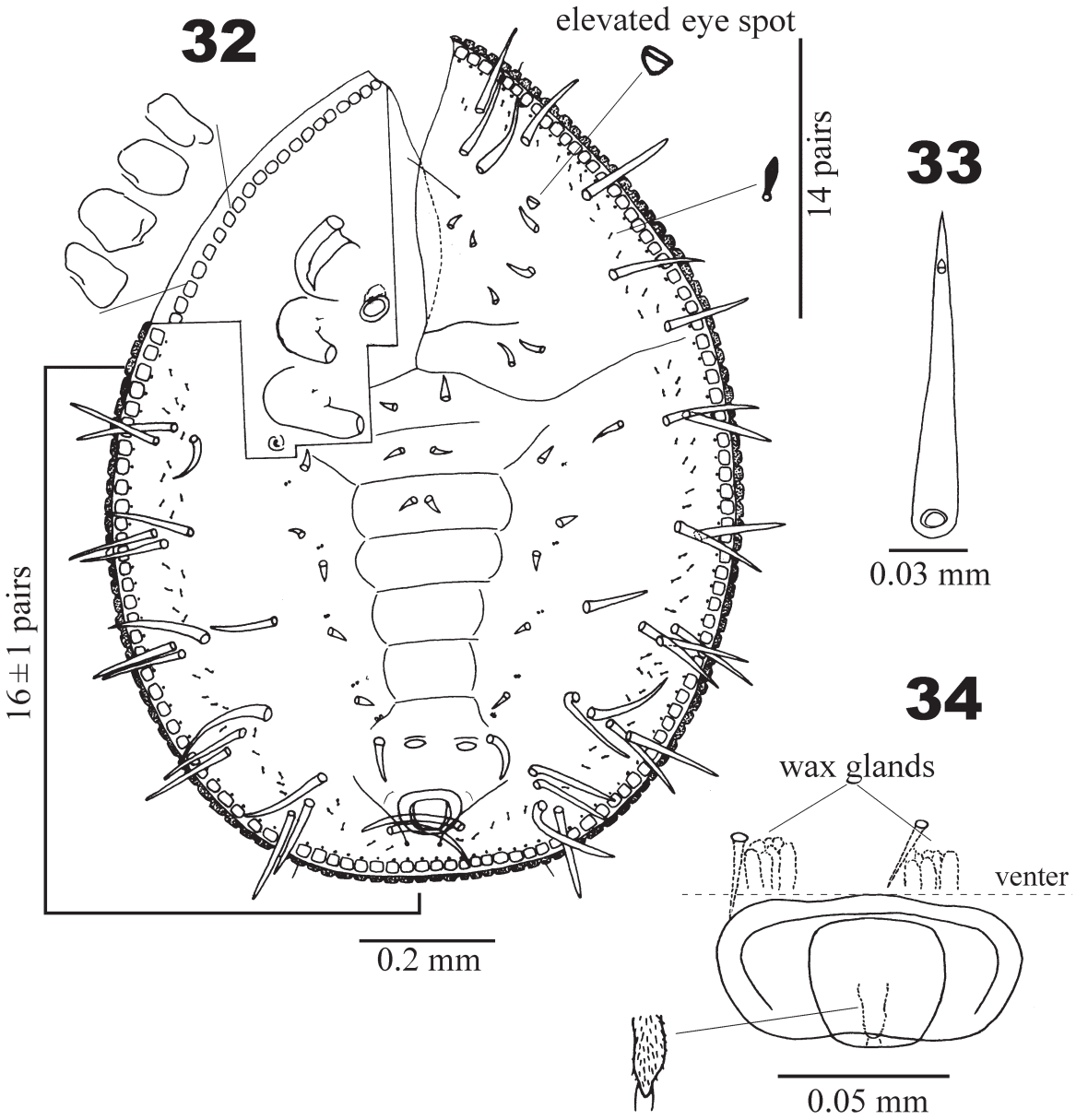


FIGURES 28–31 *A. eugeniae*, Taiwan (NTU). 28, puparium, female, dorsal and ventral views. 29, margin and wax glands. 30, submarginal spine/siphon. 31, vasiform orifice.

***Aleurocanthus lauriphaga* sp. nov.** (Figs 32–50, 67–71, Table 1–2)

PUPARIUM FEMALE. Found singly on lower side of leaves; dark black, oval, margin with white flocculent wax secretion, wax almost concealing submarginal spines, only apex visible; median area without wax deposition. Immatures of previous instars not seen on dorsal surface of puparia.

Margin: toothed, each tooth apically irregular, usually with three to four teeth in 0.1 mm, each marginal tooth with a wax secreting gland at base, wax glands turning pale after bleaching, broader incision between teeth. A minute pore present at base of each wax gland.



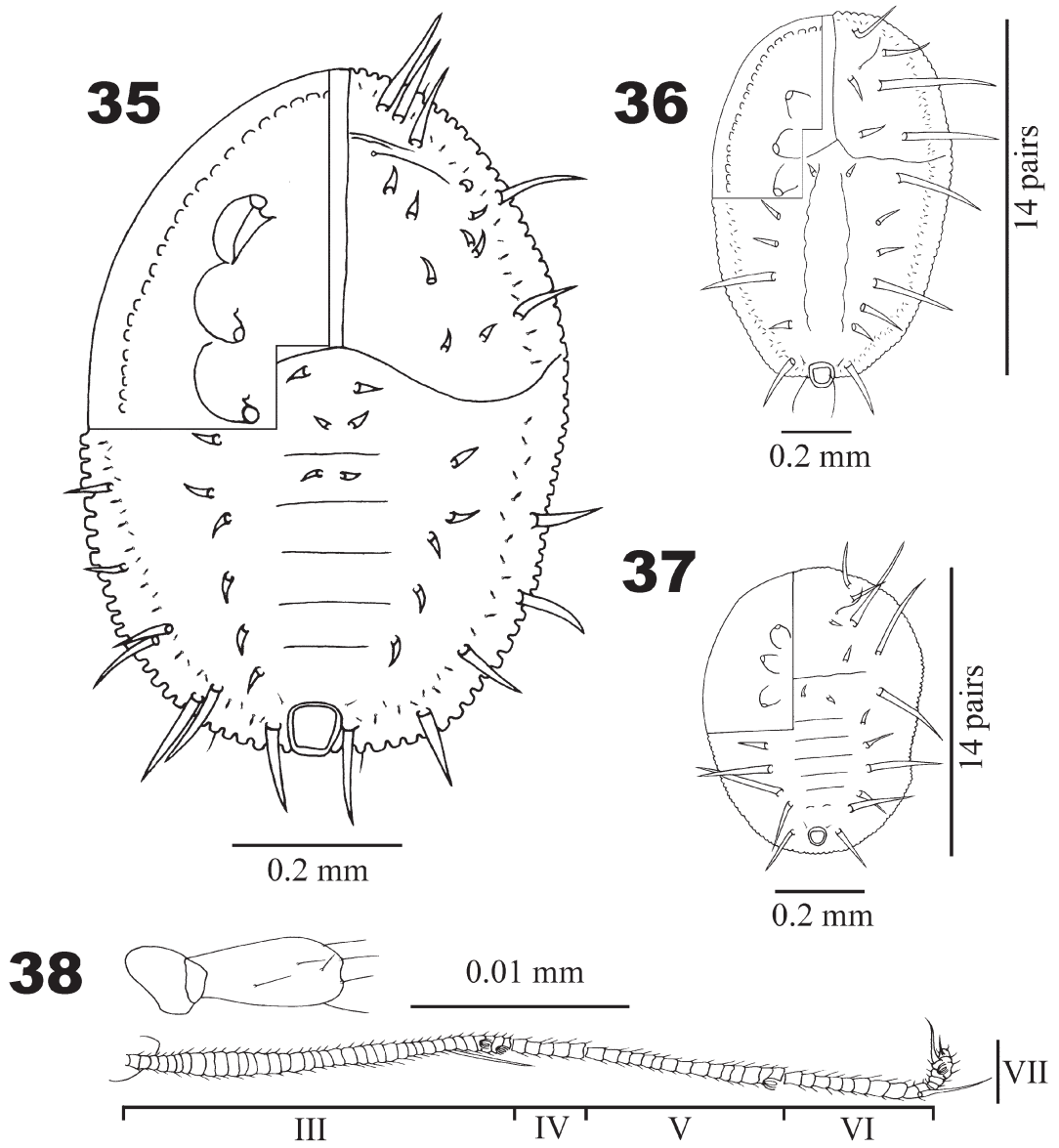
FIGURES 32–34 *A. lauriphaga* **sp. nov.**, holotype puparium, Taiwan (NTU). 32, dorsal and ventral views of holotype puparium, female, dimorphism. 33, dorsal spine. 34, vasiform orifice and ventral setae and wax glands.

Dorsum. Longitudinal moulting suture reaching margin, transverse moulting reaching submargin. Meso-metathoracic suture visible. One pair of small tuberculate processes present on submedian area of cephalothorax. Abdominal segments suture evident, rhachisform. Submargin with irregularly placed 50–61 pairs of minute spear-shaped setae. Dorsum with 39–40 pairs of spines. Cephalothorax with 14 pairs of spines, of which, five pairs on submargin and nine pairs on submedian area. Of the nine pairs on submedian area, the cephalic two pairs were three times longer than the other submedian pairs. Abdomen with 25–26 pairs of glandular spines (nine pairs on submedian area, 16–17 pairs on submargin). Of the nine pairs on submedian area, one pair located each on abdom-

inal segments I–III on inner submedian area, six pairs on outer submedian area. One spine sometimes present on subdorsal area of abdominal segment II. The bases of submarginal spines on abdomen placed usually in five transverse rows/groups, the posterior three groups comprise three to four spines, and anterior two groups comprise two to three spines. Each dorsal spine with a minute pore near apex. Abdominal segment VII nearly equal to the segment VI. Pocket on eighth abdominal segment discontinuous.

Vasiform orifice. Elevated, rectangular, slightly notched posteriorly at middle, nearly twice wider than long; operculum subcordate, filling the orifice in length and concealing lingula, the orifice laterad of operculum open. Lingula visible through operculum, reaching posterior margin of orifice, with pair of minute setae subapically.

Venter. A row of nearly square-shaped wax plates present on submargin. Antennae reaching base of prolegs. Adhesive sacs and spiracles visible.



FIGURES 35–38 *A. lauriphaga* **sp. nov.**, Taiwan (NTU). 35, male puparium, dimorphism. 36, third instar, female. 37, second instar. 38, antenna female.

PUPARIUM MALE. Same as for female except: margin toothed, five teeth in 0.1 mm, cephalic submargin with a small crease. Abdominal segments suture present but not rhachisform. Dorsum with 27–29 pairs of glandular spines. Cephalothorax with 13 pairs of spines, of which eight pairs on submedian area, three pairs on cephalic subdorsum and two pairs on submargin. Abdomen with 14–16 pairs of spines, of which three pairs are on inner submedian area, six on outer submedian area and five to seven pairs on submarginal area.

THIRD INSTAR. Oval, 0.75 microns long, 0.55 microns wide. Margin toothed/crenulate, curved ventrally, crenulations broader than long. Longitudinal moulting suture reaching margin and transverse moulting suture reaching submargin. Median abdominal ridge present. Cephalothoracic sutures absent. Abdominal segments suture not visible. Cephalic setae nearly five times longer than the eighth abdominal setae. Dorsum with 14 pairs of submedian glandular spines, six pairs on cephalothorax and eight pairs on abdomen. Submargin with many irregularly placed lanceolate setae. Vasiform orifice subcordate, 40 microns long, 50 microns wide; operculum similarly shaped, 22.5 microns long, 30 microns wide. Anterior and posterior marginal setae 6.25 microns and 25 microns long, respectively. Cephalic setae 40 microns long, eighth abdominal setae 73.75 microns and caudal setae 122.5 microns long. Ventral abdominal setae 40 microns long, 30 microns apart. A row of wax plates present on submargin. Legs conical, not curved.

SECOND INSTAR. Length 55 microns, width 37.5 microns. Longitudinal and transverse moulting suture present. Dorsal spines 14 pairs, six pairs on cephalothorax and eight pairs on abdomen. Abdominal segments sutures faintly discernable. Vasiform orifice 85 microns long, 42.5 microns wide; operculum 27.5 microns long, 26.25 microns wide. Cephalic setae 127.5 microns and caudal setae 85 microns long, eighth abdominal setae nearly five times shorter than cephalic setae, ventral setae 7.5 microns long, 23.75 microns apart.

ADULT FEMALE. Antennae seven segmented, one sensorial cone each on segment III, VI and VII; four primary sensoria, two on segment III and one each on segment V and VII; segment IV smallest; apical seta on segment VII present. Two pairs of abdominal wax plates, each with two setae on inner margin and one seta on outer margin. Metatibial comb comprises 25 setae, metatibial brush comprises two setae. Upper and lower lobes of compound eye joined by one facet. Vasiform orifice subcordate, operculum posteriorly slightly notched, posterior lateral margin of operculum with one pair of setae; lingula not segmented. Paired gonopophyses with four pairs of setae, of which, anterior two setae are placed closely near tip; unpaired gonopophysis with one pair of setae.

ADULT MALE. Same as for female except: four pairs of abdominal wax plates. Metatibial comb comprises 22 setae. Claspers apically much narrow, forming tube-like shape, mid-dorsal surface with six long setae, similar two setae on inner margin and four on outer margin, in addition two minute setae on outer margin present; subapical tooth present. Aedeagus gradually narrowed toward apex, basal one third region with microtrichia on outer margin.

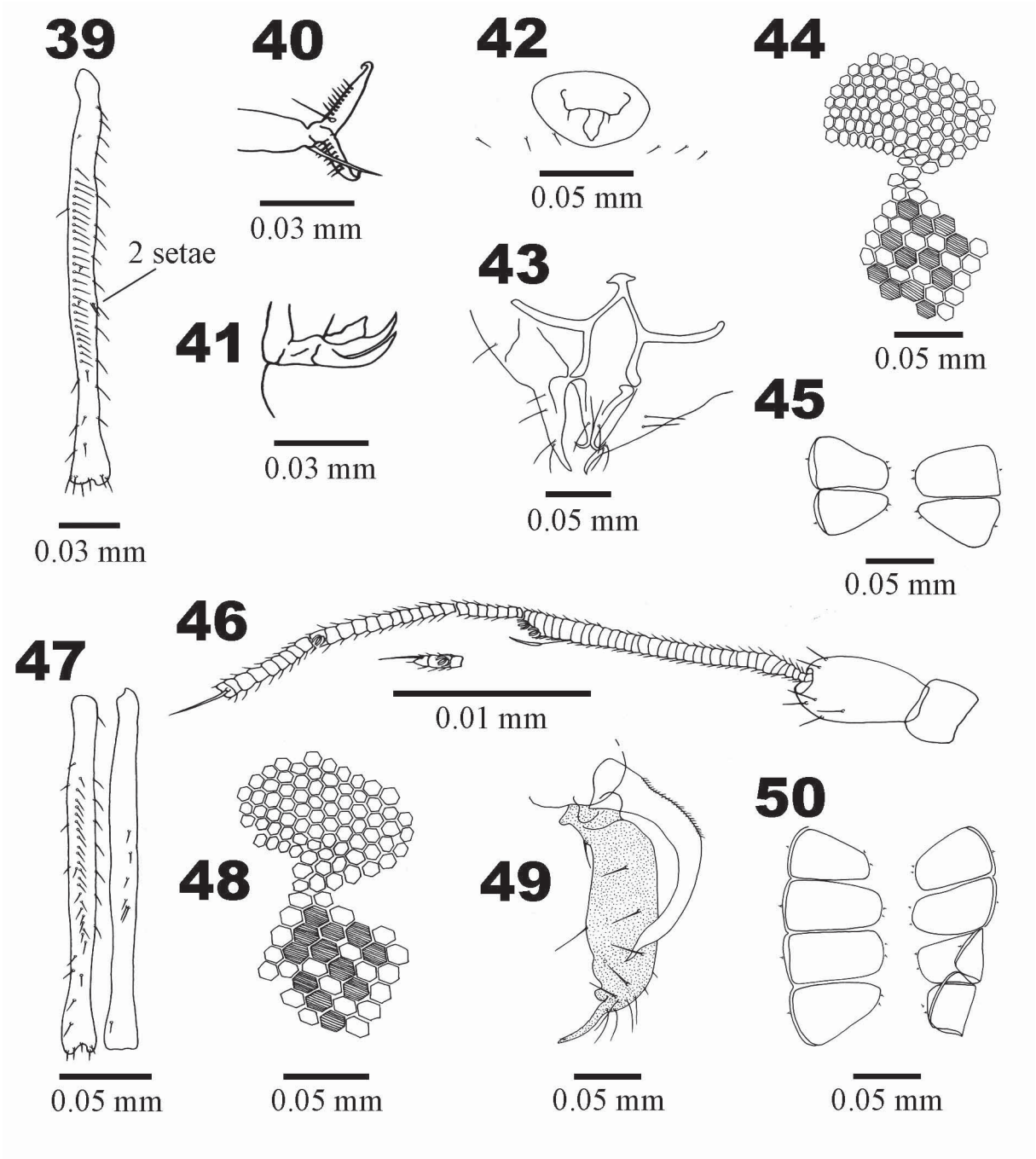
Distribution. Taiwan (Jianshi forests).

Material examined. Holotype: **Taiwan**: Jianshi forest, 1 ♀ puparium on slide, on *C. osmophloeum*, 26.iii.2009, A. K. Dubey & Y. T. Shih (5134) (NTU).

Paratypes. Fifty two female puparia and 23 male puparia on 28 slides, data same as for holotype. Other material: one male and one female adults, five third instars and two second instars on 4 slides, data same as of holotype and several puparia preserved in 95% alcohol from the same collection (NTU).

Etymology. The species epithet is derived from Lauraceae, the family of the host plant.

Remarks. The number of dorsal spines is highly variable in this species. The wax secretion pattern was unusual among *Aleurocanthus* species. The elevated eye spots resemble those in *A. cinnamomi*. The puparia of this species are unique among *Aleurocanthus* species in the placement of submarginal spines in transverse rows on the abdominal region, the square-shaped large submarginal wax plates, much paler, rhachisform abdominal segments, chitinised margin and transversely elliptical vasiform orifice, nearly two times wider than long in female puparia.



FIGURES 39–50 *A. lauriphaga* **sp. nov.**, Taiwan (NTU). **39–45**, adult female. 39, metatibia. 40, metatibial claw, ventral view. 41, same, lateral view. 42, vasiform orifice. 43, female genitalia. 44, compound eye. 45, abdominal wax plates. **46–50**, adult male. 46, antenna. 47, matatibia. 48, compound eye. 49, clasper and aedeagus. 50, abdominal wax plates.

***Aleurocanthus rugosa* Singh** (Figs 51–54, Table–2)

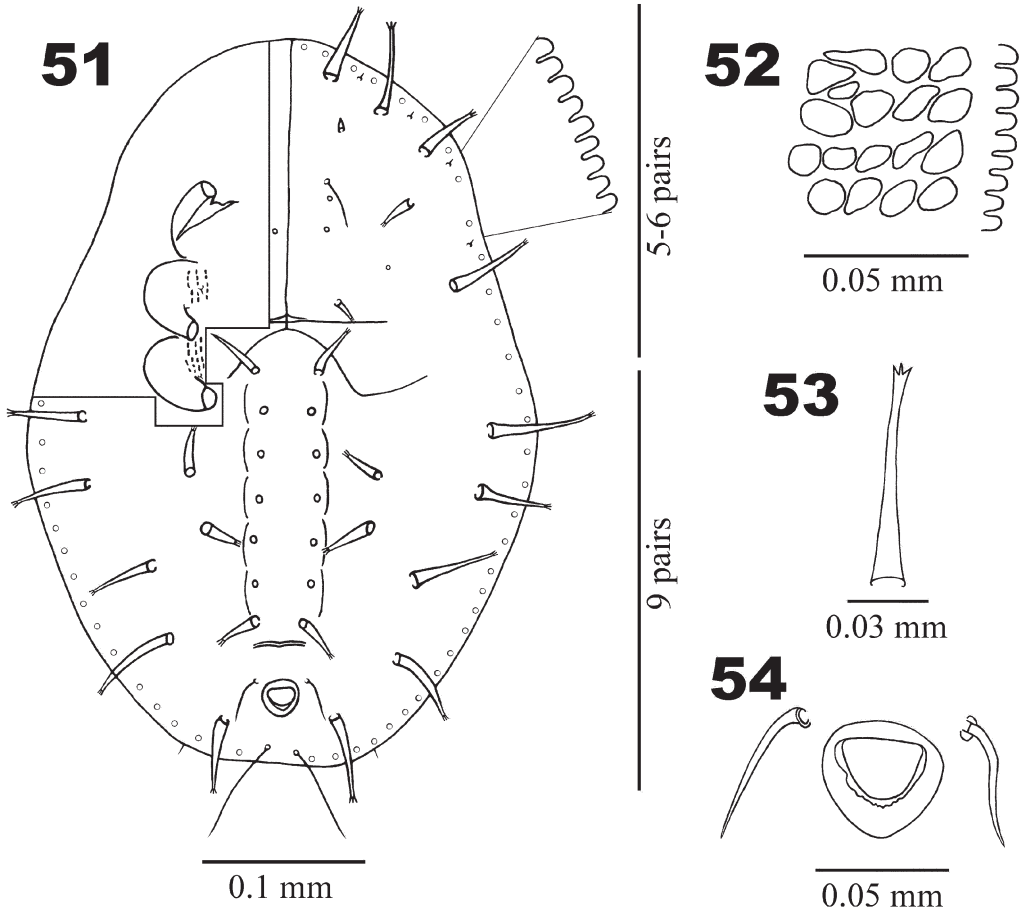
Aleurocanthus rugosa Singh, 1931: 31.

Distribution. Australia, Bangladesh, Borneo, Hong Kong, Sulawesi (Martin, 1999); India (Singh, 1931); Iran (Evans, 2007a); Malaysia (Takahashi, 1952); Taiwan (Takahashi, 1931, misidentification).

Material examined. Taiwan: Taihoku, 12 puparia on slide, 26.iii.1934; 91 puparia on 2 slides, 21.ix.1930, host label not available, R. Takahashi (TARI); Xindian, 30 ♀ & 3 ♂ puparia on 5 slides, *K. piper*, 10.ix.2010, Y. T. Shih *et al*.; Guangxing, 2 ♀ puparia, 1 third instar, on unidentified plant, 19.xi.2008, A. K. Dubey & Y. T. Shih (4600) (NTU).

Remarks. Takahashi (1931) recorded *A. spinosus* (Kuwana) from two host plants in Taiwan, *Gardenia florida* and *Piper futokadsura*. We have examined specimens he identified as *A. spinosus,* and consider that these are actually *A. rugosa*. We compared these specimens with drawings of *A. spinosus* in Quaintance & Baker (1914), and the puparia of the two species share a few characteristics such as apically fimbriate dorsal spines, median abdominal ridge, and toothed margin. However, *A. rugosa* differs from *A. spinosus* by the presence of a row of minute pores along the marginal teeth, eight to nine pairs of submarginal dorsal spines, multiple rows of submarginal wax plates, and in the number and position of spines on the cephalothorax. The puparia of *A. spinosus* are distinguishable from *A. rugosa* by the oval puparium, granulated submargin, longer operculum and in having seven pairs of subdorsal cephalothoracic spines. In *A. spinosus*, abdominal segments I−VII have a pair of spines along the median ridge, whereas in *A. rugosa* only segments I & VII have such spines, and segments II−VI have paired pores.

Dimorphism in this species is not great, but male puparia are smaller (750 by 475 microns) than female puparia (1000 by 750 microns). The spines of the third instar are also in the form of siphons. Host plant details were not available on the two slides from Takahashi, dated 21.ix.1931, but this pre-dates the 1931 publication, although no collection data were given in Takahashi (1931: 207). As a result of the re-identification of these specimens, *A. spinosus* is not known from Taiwan.

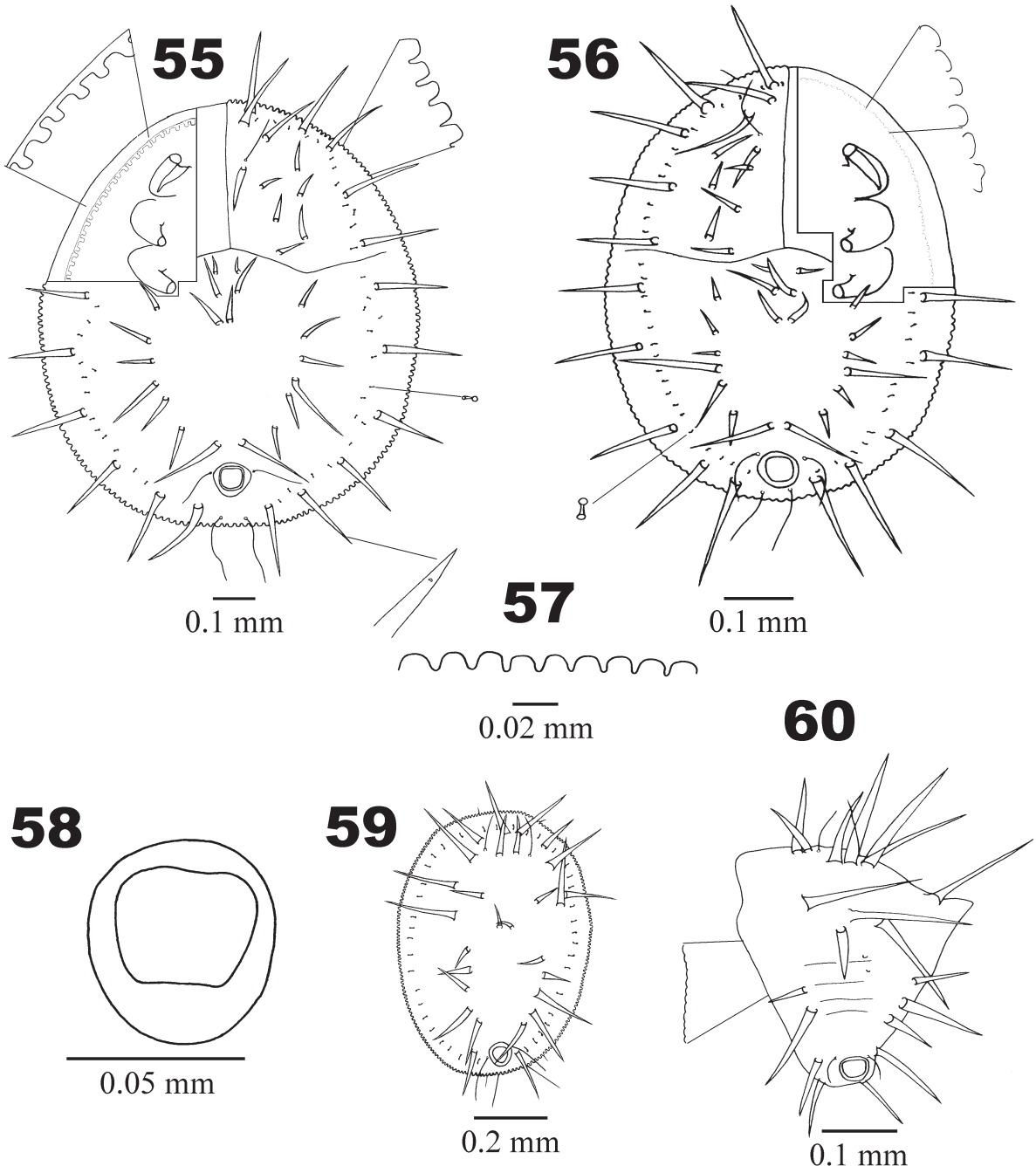


FIGURES 51–54 *A. rugosa*, Taiwan (NTU). 51, puparium, dorsal and ventral views. 52, margin and submargin. 53, dorsal siphon. 54, vasiform orifice.

***Aleurocanthus spiniferus* (Quaintance)** (Figs 55–60, 66, Table 1–2)

Aleurodes spinifera Quaintance, 1903: 63–64.
Aleurocanthus spiniferus (Quaintance) Quaintance & Baker, 1914: 102.

Distribution. Kenya, Tanzania (Newstead, 1911); Indonesia (Fletcher, 1919); Malaysia (Gater, 1924); Java (Corbett, 1926); China, Vietnam (Silvestri, 1926); Taiwan, Vietnam (Silvestri, 1927); India (Singh, 1931); Cambodia, Thailand (Takahashi, 1942); Japan, Marianas Is., Mauritius (Moutia, 1955); Micronesia (Takahashi, 1956); Philippines (Peterson, 1955); Sri Lanka (Takahashi, 1956); Bangladesh (Alam *et al*., 1965); Pakistan (Gentry, 1965); Hawaii, Sumatra (Weems, 1974); Borneo (Brunei), Hong Kong, Uganda; records from Jamaica and Congo seem to be based on misidentifications (Mound & Halsey, 1978).



FIGURES 55–60 *A. spiniferus*, Taiwan (NTU). 55, puparium, female, dimorphism, dorsal and ventral views. 56, puparium, male, dimorphism, dorsal and ventral views. 57, margin. 58, vasiform orifice. 59, female third instar. 60, second instar.

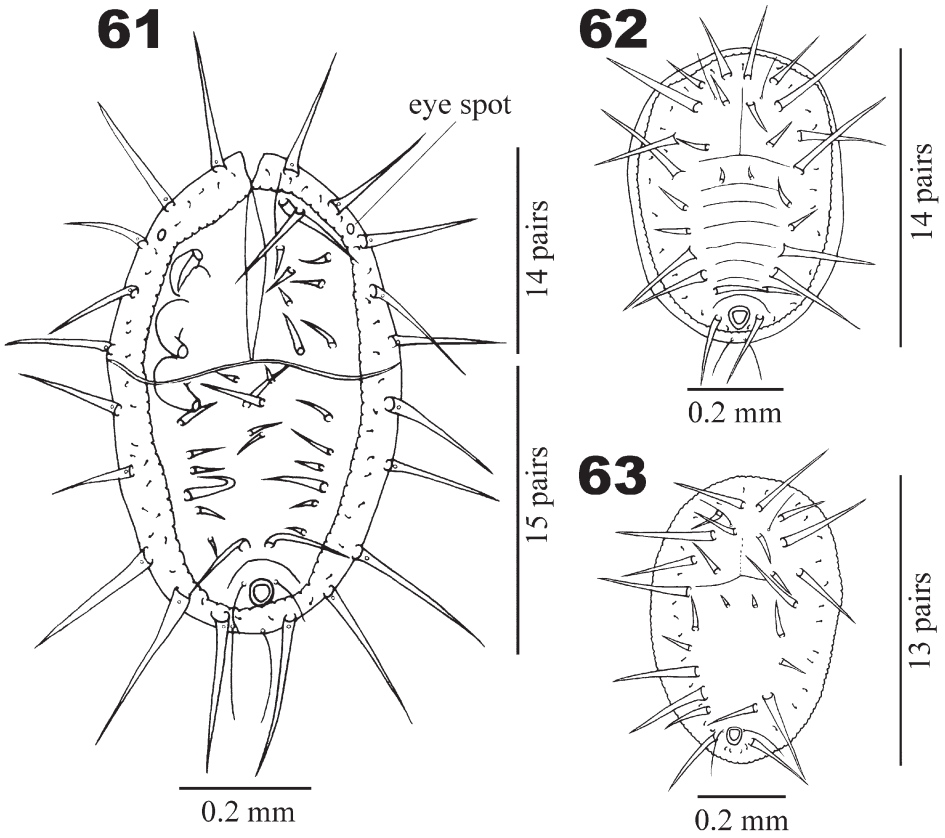
Material examined. Taiwan: Chiayi, Fanlu, 202 ♀ & 24 ♂ puparia, 17 third instars, 13 second instars, 3 ♀ & 1 ♂ adults, on *Citrus* sp., 22.x.2005; 1 ♀ puparium on *M. pubescens*, 4.xi.1994 (1370); Loloshan, 14 ♀ & 6 ♂ puparia on *R. ellipticum*, 13.ii.1987; 1 ♀ puparium, on *A. longeracemosa*, 26.v.1995; 1 ♀ puparium, on *A. longeracemosa*, 12.v.1995; Hsinchu, 1 ♀ puparium on *L. formosana*, 20.v.1994 (753); Kenting, 1 ♀ puparium and 1 third instar on *A. formosana*, 23.vi.1994 (915); 1 ♂ puparium on *T. formosana*, 1.i.1995 (1654); Ilan, 3 puparia on *S. samarangenes*, 23.ix.1993; 1 ♀ puparium on *M. perlaria*, 14.iv.1994 (612); Wulai, 1 ♀ puparium on *P. formosana*, 10.xii.1994 (1546); Taichung, 1 ♀ puparium on *G. jasminoides*, 17.iii.1994; Yamingson, 1 ♀ & 1 ♂ puparia on *B. blinii*, 27.i.1994 (429, 844); all C. C. Ko; Xindian, 28 ♀ & 11 ♂ puparia, on *K. piper*, 10.ix.2010, C. T. Chen (5961); Muzha, 2 ♀ puparia on *B. densiglomerata*, 23.viii.1994; Nantou, 1 ♂ puparium on *B. championii*, 17.vii.1995; Taichung, TARI, 5 ♀ puparia on *P. serotina*, 27.x.1994; all K. C. Chou; Yamingshan National Park, 12 ♀ puparia, on unidentified plant, 16.i.2009, A. K. Dubey & Y. T. Shih (4870) (NTU).

Remarks. This species differs from *A. woglumi* in having 11 pairs of submarginal spines, none of them doubled, and seven to nine marginal teeth in 0.1 mm. It is a dimorphic species, in which, adult males are much smaller than adult females, and the wings usually ashy white in appearance; adult female without wax deposition on wings, with orange colour head and black wings, nearly three times longer than males.

Aleurocanthus woglumi **Ashby** (Figs 61–63, Table 1–2)

Aleurocanthus woglumi Ashby, 1915: 321–322.
Aleurocanthus punjabensis Corbett, 1935a: 8–9. Synonymised by Husain & Khan, 1945: 1–2.
Aleurocanthus woglumi var. *formosana* Takahashi, 1935: 281–283. Synonymised by Mound & Halsey, 1978: 24.

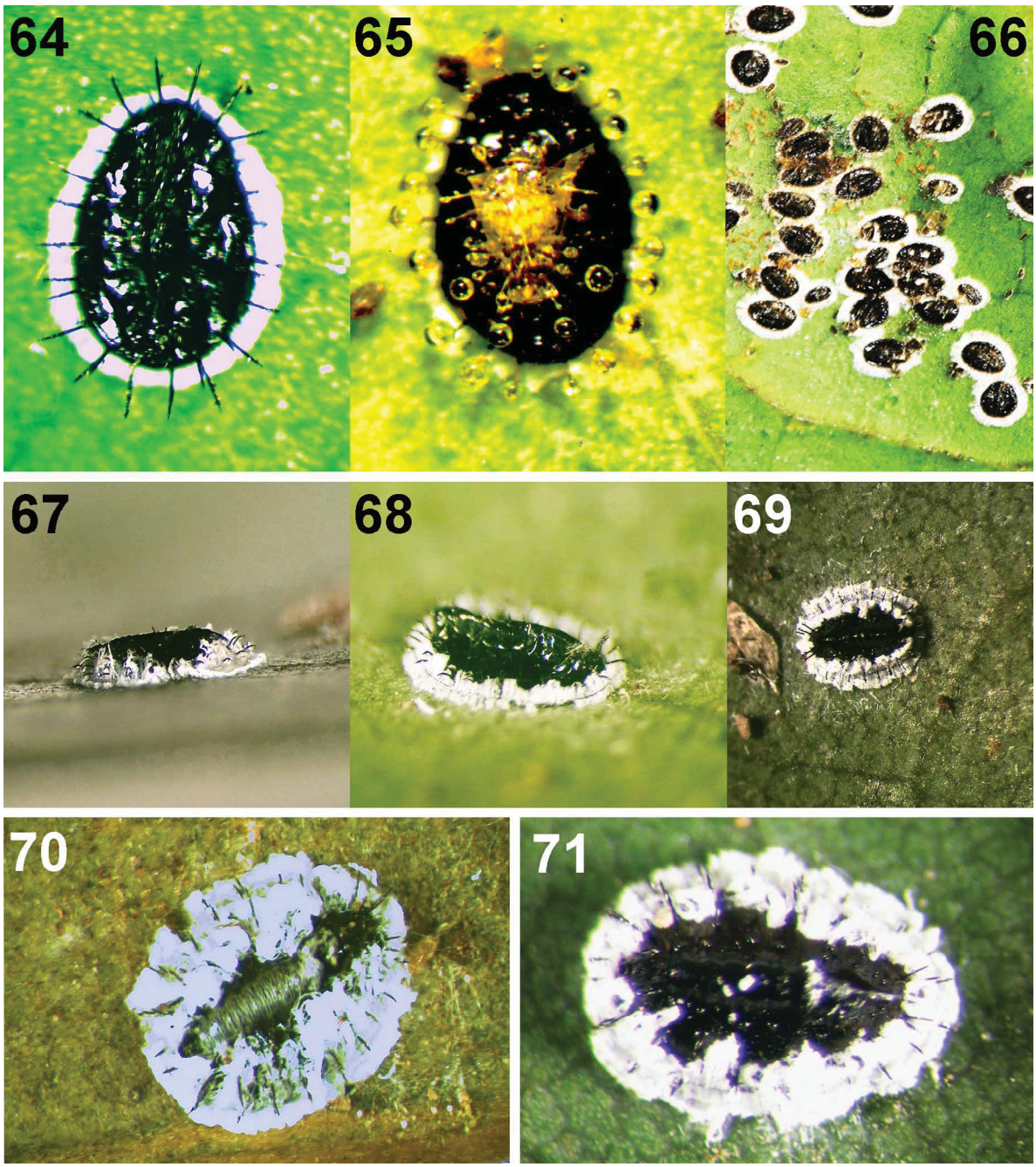
Distribution. Jamaica (Ashby, 1915); India (Singh, 1931), China (Takahashi, 1934a); Pakistan (Corbett, 1935a); Thailand (Takahashi, 1942); Taiwan (Takahashi, 1935); Iran (Kiriukhin, 1947); Burma, Java, Hawaii (Thompson, 1950); Barbados, Bermuda, Colombia, Costa Rica, Cuba, Ecuador, Haiti, Dominican Republic, Kenya, Malaya, Mexico, Nicaragua, Panama, Philippines, Seychelles, Singapore, South Africa, Sri Lanka, Sumatra, U.S.A. (Russell, 1962); Bahamas, Borneo, Cayman Is., Nepal, Tanzania, Trucial States, Uganda (Mound & Halsey, 1978).



FIGURES 61–63 *A. woglumi*, Taiwan (NTU). 61, puparium, male, margin toothed, folded, dimorphism, dorsal and ventral views. 62, female third instar, margin folded. 63, male third instar.

Material examined. Taiwan: Taihoku, 41 (21 ♀, 3 ♂ complete and remaining broken) puparia on *Pyracantha* sp., 21.iii.1934, R. Takahashi (TARI); Kaoshiung, 43 ♀ puparia on 10 slides, on *Citrus* sp., 2.ix.1987; Nantou, 1 ♀ puparium on *Actinidia* sp., 7.vii.1994 (945), all C. C. Ko; Sanxia, 7 ♀ & 3 ♂ puparia, 5 ♂ & 41 ♀ third instars, on *M. zuihoensis*, 13.viii.2010, C. T. Chen (5979) (NTU).

Remarks. This whitefly is a common pest of *Citrus* species. The male puparia have 10 pairs of submarginal spines, five pairs each on cephalothorax and abdomen, none of them doubled. In contrast, the female puparia have seven pairs of submarginal spines on the abdominal region, of which the posterior most third pairs are doubled at the base. Submedian spines on the cephalothorax do not reach beyond the margin, except the anterior two pairs. Longitudinal and transverse moulting sutures reach the margin. Eye spots evident. Vasiform orifice circular; operculum usually notched at hind end. Dimorphism was also clear in third instars, the female third instars possessed 14 pairs of spines whereas male third instars only 13 pairs.



FIGURES 64–71 Microphotographs. 64, *A. cinnamomi* on *Machilus zuihoensis*. 65, *A. martini* on *Santalum album* (India). 66, *A. spiniferus* on *Citrus* sp. 67–71, *A. lauriphaga* sp. nov. 67, puparium, male, lateral view. 68, same, dorso-lateral view. 69, same, dorsal view. 70, puparium, female, dorsal view with metallic median area. 71, same, dorsal view with cumulus wax around puparium and submargin.

Discussion

Aleurocanthus species feed both on monocotyledonous and dicotyledonous host plants, and some of them are often quarantined from *Citrus* sp. Of the 11 *Aleurocanthus* species listed from *Citrus* sp. (Evans 2007a), three species, *A. citriperdus*, *A. spiniferus* and *A. woglumi* are considered to be invasive and cause serious damage.

In *A. eugeniae*, the presence of spines/siphons only on the submargin and first abdominal segment, none reaching beyond the margin, and the half covered orifice, suggest a separate group within *Aleurocanthus* or possibly a separate genus. Likewise, *A. rugosa* puparia possess several laciniate spines/siphons, and the vasiform orifice characteristics place it much closer to *Siphoninus* Silvestri than *Aleurocanthus*. We understand *A. rugosa* is not a true member of the genus, and *A. davidi* David and Subramaniam (1976) from India belongs to same group or is possibly a synonym.

The newly invaded whitefly to Taiwan, *A. citriperdus*, is infesting *C. sinensis* with high populations, and is likely to cause serious damage; the natural enemies for this pest are under exploration from this island. Evans (2007b) catalogued 27 species of parasitoids from *Aleurocanthus* species, which includes *Eretmocerus orientalis* Gerling (1970) and seven *Encarsia* species recorded from Taiwan.

All six of the recorded parasitoids of *A. citriperdus* (*Ablerus inquirenda* Silvestri (1928), *Eretmocerus serius* Silvestri (1928), and four *Encarsia* spp.) are distributed in the Oriental Region. Except *Encarsia merceti* Silvestri (1926), the other three *Encarsia* species, *En. clypealis* Silvestri (1928), *En. divergens* Silvestri (1926) and *En. smithi* (Silvestri, 1926) were introduced to the New World. *En. smithi* is also recorded to parasitize *A. spiniferus* and *A. woglumi*, and the presence of this parasitoid in Taiwan indicates that this could be a candidate for the biocontrol of *A. citriperdus*.

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